Quantum Field Theory for Philosophers

Transparencies

1.) Classical Concept of Field.

2.) Field Approach to Classical Particle Physics

3.) Field Quantization

3a) Field Quantization contd

3b) Field Quantization contd.

3c) Field Quantization contd.

4.) Second Quantization.

5.) Fock Space. — Creation and Annihilation Operators.

5a) Fock Space contd.

6.) State Label permutations

7.) Re Two Routes to Quantum Field Theory.

8.) Fermion and commutators.

9.) Causality in QFT. ~~— Spin Statistics Theorem.~~

9a) Spin — Statistics Theorem.

10.) Parafields

11.) Creation and Annihilation Operators in Classical Mechanics

12.) Matter and Force.

13.) Statistical Weights of 2-particle system.

14.) Quantum Statistical Mechanics

15.) Re Bridge/Irreducibility Principle

16) Virtual Particles

17) Does exchange of virtual particles always produce Repulsion?

Summary version

Quantum Field Theory for Philosophers

Introduction QFT as guide to metaphysics

Classical Concept of Field show (1)

Field Theory v. Particle theory

What do we mean by an individual?

Field Approach to classical particle physics show (2)

Undetermination theme ~~field~~ v. particle

(History of Classical Field Theories)

10min Quantum Field Theory

Two main Approaches:

Field quantization show (3), (3a), (3b), (3c)

Second quantization show (4)

Fock-Space. show (5), (5a)

Creation/annihilation Operators

State-label permutation show (6)

5' 'Real' field field quantization → Quantum Field

N-Particle S.E. 2nd quantization

show (7)

↓ (8) (Kumar Paths)

20min Theory Is Quantum Field Same Animal in the two cases?

Responses 1) real field v. complex field

2.) Boson — classical field limit
v Fermion — . particle limit

3.) Massless fields (renormalizable)
v. massive fields

4.) Wilsonian programme — particle Approach

5.) Causality condition show (9)
↳ Spin-Statistics Theorem (9a)
But cf Parafields

Green Criteria for field quantization — show (10)

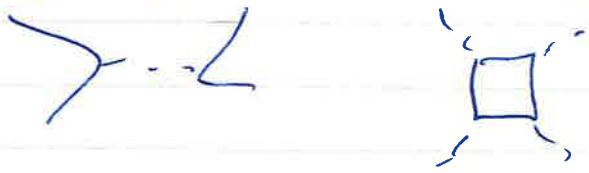
Creation and annihilation operators in classical Mechanics show (11)

↳ Kalau — Mutaphallenum
Fermi (1933) for true particle creation

Wave-Particle Duality

No does not commute with $\mathcal{H}(\hat{x}, \hat{p})$ or $\mathcal{L}(\hat{x})$

Matter fields and Force Fields show (12)



what is force particle?
v. matter particle?

cf Bootstrap programme.

Gauge Theories — QCD, Superconductivity
Extended Supergravity, unification of force and matter

What do we mean by beyond?

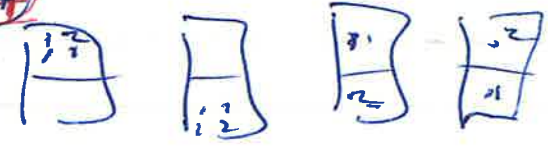
Contrast E/H bifurcation with gauge theory complication

40 min

Re Problem of Individuality

Elementary particles do not possess TI → not individuals.

show (13) → (14)



Strict - Nodes argument

Limitations on accessibility of states if TI is assumed.

Indeterministic Principle show (15)

Restriction on observables ⇒ para statistics

Restriction on states ⇒ Bose/Fermi statistics

Connection between para particles and parafields.

Spatio-temporal continuity of trajectory of individuals

50 min

Vacuum $N_k = 0$ but fluctuations in $\Phi(x)$ etc.

— explains Lamb shift etc — Casimir Effect.

of extended particle interpretation -

show (16)

Virtual Particles

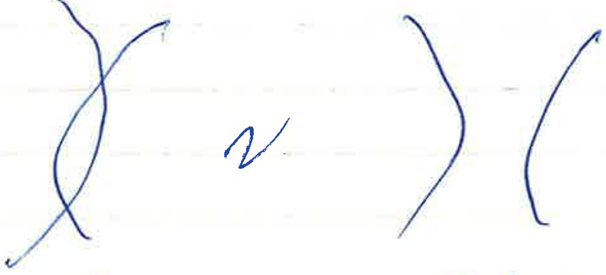
$H_0 + H'$ solved in terms of H_0 solutions.

Solved $|\Psi'\rangle = |\Psi\rangle + -$ virtual particle states

— Internal lines of Feynman diagrams.

Why exchange can produce attraction as well as repulsion

Show (17)



Attraction Repulsion

55mm

Conclusion

1.) Continuous v. Ephemeral.

2.) Particle approach assumes TJ. if state description complete-

So philosophical arguments against TJ tell against particle approach

3.) Heuristic role of field theory

4.) Ambiguous attitude to QFT — infinities — renormalization — Weinberg-Salam — Triumphant prediction & ability to calculate.

5.) Moral Do not abandon programme in face of
1) inconsistency (infinities)
2.) lack of novel predictions due to computational gap

Concluding remark — Nothing has happened since 1930

Plea for informed & critical discussion of interpretation of QFT by philosophers